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NOTES ON THE SPAWN AND EARLY LIFE HISTORY OF TWO SPECIES OF *CONUBER* FINLAY & MARWICK, 1937 (NATICIDAE).

By FLORENCE V. MURRAY, M.Sc.*

Plates 6-9.

ABSTRACT.

C. conicum and *C. sordidum* differ from other naticids whose breeding is known, in spawning gelatinous egg masses rather than sand-encrusted egg collars. The larvae of both species hatch as free-swimming planktotrophic veligers.

Genus *CONUBER* Finlay & Marwick, 1937, Palaeont. Bull. *N.Z.* 15: 53.

Natica conica Lamarck, 1822, Anim. s. Vert., 6, (2): 198.

Natica sordida Swainson, 1821, Zool. Illustr., 1: pl. 79.
= *Natica plumbea* Lamarck, 1822, Anim. s. Vert., 6, (2): 198.
= *Natica strangei* Reeve, 1855, Conch. Icon., 9, *Natica* pl. 18, fig. 81.

INTRODUCTION.

The existence of an atypical naticid spawn had remained unrecognised until February, 1962, when the specimen (Nat. Mus. Vict., No. F. 22726) of the Conical Sand Snail, *Conuber conicum* (Lamarck, 1822), which had been isolated in a small home aquarium produced a large gelatinous

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egg mass (Murray, 1962) consistent with the "Sausage-blubber" illustrated by Dakin (1952, Pl. 54) and described by him as a gastropod egg mass of unknown parentage. Investigations then revealed that the Sordid Sand Snail, *Conuber sordidum* (Swainson, 1821) produces a similar spawn.†

These observations were subsequently confirmed by Miss J. H. Macpherson, Curator of Molluscs at the National Museum of Victoria in Melbourne, and by Dr. R. J. MacIntyre of the C.S.I.R.O. Division of Fisheries and Oceanography at Cronulla, N.S.W., both of whom isolated the species concerned in laboratory aquaria where identical gelatinous egg masses were spawned.

As it has hitherto been believed that all species of Naticidae embed their egg capsules in a gelatinous matrix impregnated with sand in the form of a "characteristic" spiral sandy ribbon or egg collar, it comes as a surprise to find that some members of the family spawn egg masses of this sausage-blubber type.

Such egg masses are found stranded on sand and seaweed at low tide or floating in ebbing water: they are common objects on the seashores around Australia embracing latitudes of approximately 15°–45°S. and longitudes of approximately 115°–155°E.

C. conicum ranges from south-west Australia, through southern Australia, Tasmania, New South Wales and Queensland: it is common on sandy flats, but is also found in sandy mud areas. *C. sordidum* has much the same range, but does not extend to Tasmania: it inhabits sandy mud tidal flats and estuarine areas.

BREEDING HABITS.

The females of both species are, on the average, slightly larger than the males, as in most prosobranchs, but the shells display little evidence of sex dimorphism.

The breeding season in Victorian waters is about the same for both species—from spring to autumn—although isolated egg masses of *C. conicum* have been collected as late as June, and *C. sordidum* tank-spawned in July at a temperature of 19°C. Fluctuation in the numbers observed of *C. conicum* masses in Port Phillip Bay might well indicate some lunar influence, e.g., they were in abundance during Easter (April 21-22, 1962) but sparse before and after that time. Periods of prolific spawning by *C. sordidum* at Mallacoota Inlet in eastern Victoria, have been noted by Mr. F. Buckland, an experienced member of the fishing industry, who has at times had fishing nets completely fouled with their large gelatinous spawns.

Mating has not been observed, but at least in *C. conicum* it must considerably precede the spawning process, the female having the capacity to store spermatozoa. This was evidenced by *C. conicum* (No. F. 22726) which had been isolated for a month before spawning, then within ten days produced three egg masses measuring 8, 5 and 3 cm. respectively across the outer diameter. The eggs in all three masses were fertile. This

† Since these notes were prepared, Mr. B. Wisely of the C.S.I.R.O. Division of Fisheries and Oceanography has sent me a gelatinous egg mass of the same type spawned by *Conuber melastoma* (Swainson, 1822): it will be reported upon at a later date.

snail was large, measuring 42 x 28 mm.; a very much smaller specimen, only 20 x 14 mm. spawned a scarcely-curved mass 3.5 cm. long, possibly indicating that this species breeds in its first year. Thus either large or small snails may be responsible for the small egg masses found in the field.

The stages of growth leading to the adult of *C. sordidum* appear to take place mainly in intertidal areas judging from the abundance of juveniles of all ages on the sandy mud beaches at low tide in Western Port localities during summer and autumn. What happens in the case of *C. conicum* is not clear. At no time have small juveniles been seen on the sand flats at Rosebud, in Port Phillip Bay, where large adults are plentiful most of the year and egg masses present throughout the breeding season; but they are to be found at extreme low tide on the sheltered ocean beach in the San Remo channel.

THE SPAWN

(Plate 6.)

In general the egg mass of each species is an incomplete annulus formed by a thick, spiral gelatinous band standing on edge; it varies in length, height (width) and thickness. The outer wall between the basal and apical margins is convex while the inner wall bears the impression of the part of the shell and foot of the animal over which it was formed.

In view of the general similarity in form between these gelatinous spawns and the more typical sand-collars of other naticids, it seems desirable to replace the colloquial term "sausage-blubber" by the more accurate designation "gelatinous egg collar" in describing these egg masses.

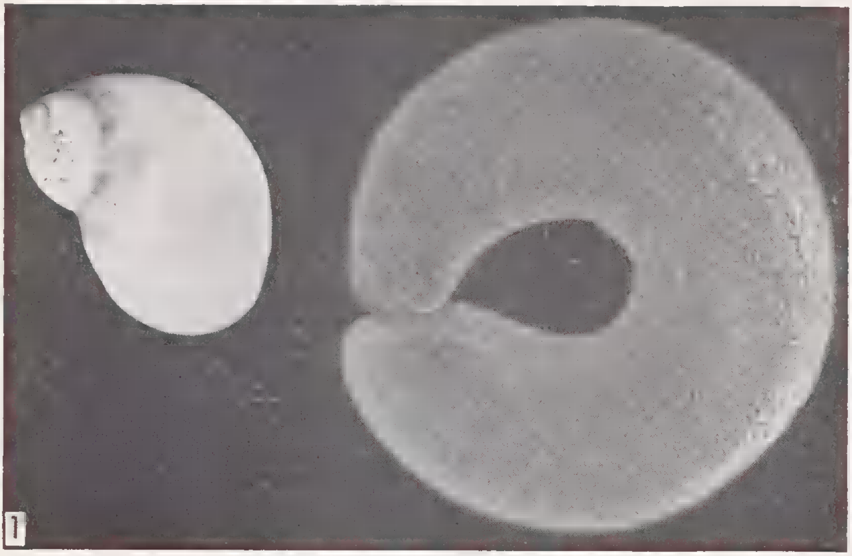
A gelatinous egg collar is composed of a clear, solid jelly diffused with egg capsules and invested with a thin, closely adhering, tough, transparent integument in which there is an overlapping seam along the inside wall extending to the base of the vertical margins.

When hatching begins the integument sloughs off and the jelly slowly dissolves away. The first egg mass spawned by *C. conicum* (No. F. 22726) weighed five ounces and completely dissolved in four days after the first veligers emerged, at a water temperature averaging 25°C. At lower temperatures dissolution takes considerably longer.

It seems remarkable that such small molluscs can suddenly create such massive spawn, but as might be expected, the jelly is mostly sea-water, only a very small amount of organic matter being produced by the animal. An analysis made by the State Laboratories in Melbourne showed the jelly of *C. sordidum* to consist of 96.3% water and 3.7% solids including 3% chlorides expressed as common salt (NaCl).

In general the gelatinous egg collar spawned by *C. sordidum* is larger than that spawned by *C. conicum*, but in each case there is a considerable range in size as indicated by the following measurements taken from field material:

		Outer diameter	Length (Basal Margin)	Weight
C. sordidum	Maximum	10 cm.	27 cm.	7.5 oz.
	Minimum	5 cm.	12 cm.	1.5 oz.
C. conicum	Maximum	9 cm.	25 cm.	5.5 oz.
	Minimum	2 cm.	4 cm.	0.3 oz.



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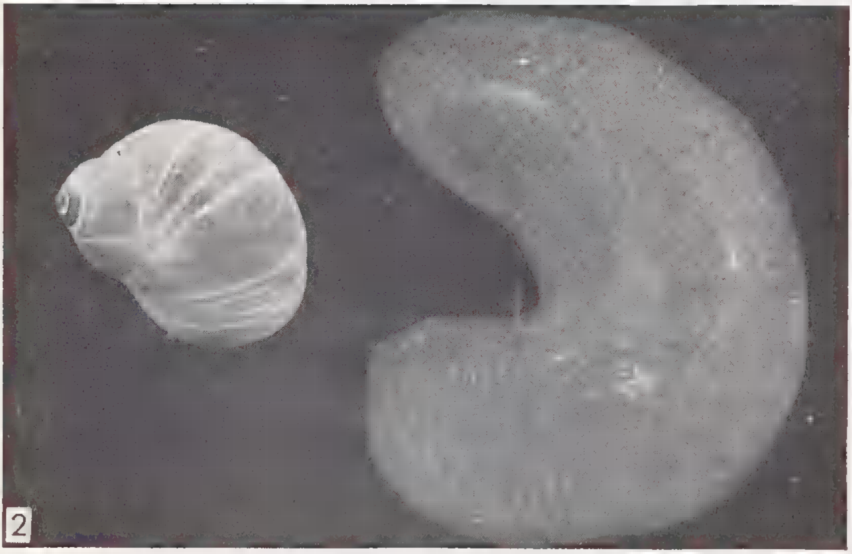

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PLATE 6.

Fig. 1: *Conuber conicum* (Lamarck). Shell: 42 x 30 x 23 mm. Spawn: diameter 72 mm.

Fig. 2: *Conuber sordidum* (Swainson). Shell: 41 x 35 x 28 mm. Spawn: diameter 85 mm.

METHODS.

Egg masses were maintained in a small temperature-controlled tank of sea-water with constant aeration. They were removed at regular intervals for examination, without interference, through a stereoscopic microscope, the transparency of the jelly allowing the developing embryos to be seen clearly. Thin sections of jelly, and egg capsules individually dissected from the mass were also used. Photomicrographs proved helpful in checking measurements and some morphological details. Veligers were maintained in small jars of sea-water at room temperature; they were pipetted into fresh sea-water every 24 hours.

THE EGGS
(Plates 7 and 8.)

The distribution of the egg capsules in the egg mass of each species is similar. They are aggregated mainly at the periphery and are sparse toward the interior. Those of *C. sordidum* are larger and more widely spaced than those of *C. conicum.*

In each species the egg is cream-coloured, spherical and covered by a vitelline membrane; it lies within a spherical, elastic envelope with a covering of fine concentrically arranged membranes. The whole is suspended in a clear, viscous material containing fine eccentrically arranged membranes and separated from the jelly of the mass by a thin, transparent pellicle forming an outer spherical capsule of constant size. Two eggs are sometimes found within one capsule, and on occasions three or more may be seen together, each developing normally The outer capsule of *C. sordidum* eggs is visible under the usual magnifications of stereomicroscopy, but that of *C. conicum* is only detectable at high magnifications or by use of special methods.

The egg envelope begins to expand with the onset of cleavage; it doubles in diameter during development and so nearly fills the outer capsule before finally breaking down to liberate the veliger. As the size of the envelope increases the viscous contents of the outer capsule progressively diminish.

The eggs of the two species may be distinguished by the following average diameter dimensions:

	Unsegmented egg	Outer capsule	Envelope (Trochophore)	Envelope (Mature veliger)
C. sordidum	0.250 mm.	0.625 mm.	0.375 mm.	0.525 mm.
C. conicum	0.125 mm.	0.300 mm.	0.175 mm.	0.275 mm.

These measurements relate to material from southern Victoria: some variations occur in the spawn of *C. sordidum* from eastern Victoria, e.g., the veligers hatch when the envelope is only about 0.45 mm. across and does not fill the outer capsule.

DEVELOPMENT.

The overall rate of development varies with the temperature, but there is always a time lag between the first and last hatchings.

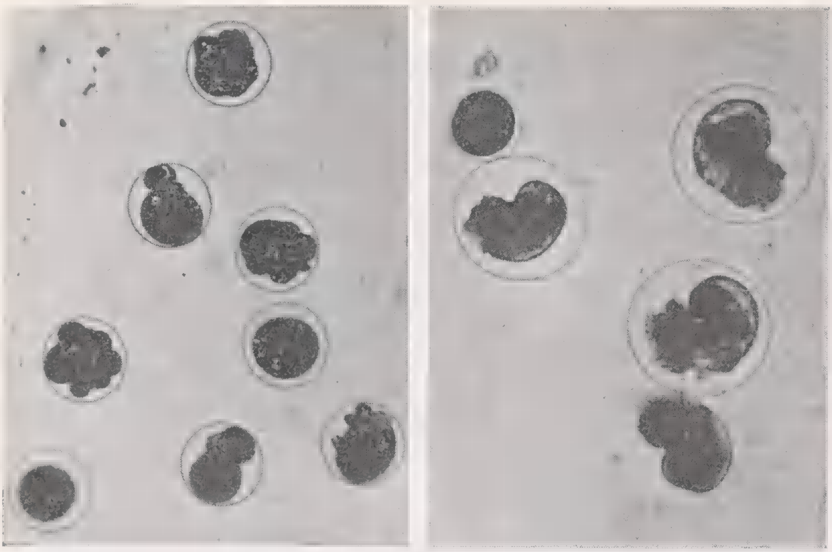

PLATE 7.

C. conicum (Lamarck). Sections of the same egg mass: eggs at various stages of development; envelopes showing progressive expansion. (Outer capsules not apparent). Photomicrographs x 57.

C. sordidum. At a temperature of 20°C the first veligers emerge from an average-sized egg mass in 10 or 11 days and the last in about 18 days. In the following brief outline of development the periods recorded for the various phases relate to the first hatchings only; these vary considerably for subsequent hatchings.

The first two cleavages are almost equal while the third gives rise to four small, transparent micromeres and four large, yolky macromeres. Subsequent cleavages result in the micromeres spreading over the macromeres and a blastula is formed within 12 hours. A flattened gastrula follows which leads to the first larval phase — the trochophore — during the next 36 hours. The various organs of the trochophore then gain in development, and within another 48 hours the second larval phase—the veliger—begins. The outgrowth of the foot and the enlargement of the prototroch as a bilobed velum commences with this 4-day larva or early veliger, which precedes torsion, and the shell, a thin, cuticle-like cap at the posterior end of the body begins to spread. The foot then becomes ciliated and develops paired statocysts and an operculum; two small black eyespots appear on the head from which the yolk now begins to clear. Development continues, and by the seventh day the young veliger is rotating vigorously within its envelope by means of large, strongly-beating cilia which have developed on the lobes of the enlarging velum. By the eighth day most of the yolk has cleared; purplish-black pigment has

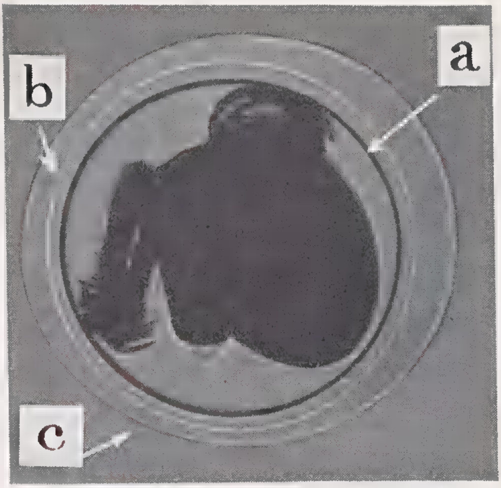

PLATE 8.

C. sordidum (Swainson). Egg capsule containing a young veliger. a = egg envelope, b = outer capsule, c = jelly of the mass. (The fine membranes in the layer surrounding the envelope and in the outer capsule are not apparent).
(x 90) Photomicrograph: slightly retouched.

darkened the visceral coil, oesophagus and intestine; peristalsis is apparent; and the mantle and shell have spread dorsally as far as the position of the larval heart, a transparent sac pulsating strongly. During the succeeding days the lobes of the velum lengthen and acquire a line of purple pigment at the margins; the mantle and shell advance forwards beyond the heart area and a vesicle, probably the early gill anlage, is apparent in the roof of the mantle; the kidney becomes more clearly defined, and the propodium first appears as a small process towards the base of the foot. On the tenth or eleventh day, after some further growth and differentiation, the veliger escapes from the envelope and capsule and works its way through the jelly into the water.

C. conicum. The development of this species follows in general the pattern outlined above for *C. sordidum,* but with some differences. The hatching period is shorter at corresponding temperatures. At 20°C the first veligers emerge in six or seven days; they have a lot of residual yolk and are not as well developed as the first *C. sordidum* veligers to hatch at this temperature. Only a comparatively small amount of pigment is associated with the gut and this appears to be linked in some way with the rate of development. Veligers hatching quickly at 20°C or more, have no pigment, but traces of it appear in those which stay alive for five or six days: it also appears, before hatching, in veligers which develop slowly at low temperatures. The foot does not develop a process-like propodium either before hatching or during the short free-swimming period in culture.

THE VELIGERS

(Plate 9.)

The veligers of both species are planktotrophic and swim about actively, constantly approaching the surface of the water and then turning away. *C. sordidum,* very much the larger of the two, lives for about 16 to 20 days in artificial conditions, but *C. conicum* rarely survives for more than 5 or 6 days.

The external body parts of both veligers are colourless. Each has a bilobed velum, the margin of which has a thick rim edged with large and small cilia, and on the underside another smaller ridge edged with short cilia. Between these two ridges is a finely ciliated groove leading to the mouth. The velum lobes of *C. sordidum* are almost rectangular, average 0.4 mm. in length and have a line of small blocks of purple pigment round the margin; those of *C. conicum* are rounded, average 0.15 mm. in length and have a row of small pigment blocks at the margin. In each, the small black eyespots are well below the base of the very short tentacles; the statocysts, embedded in the base of the foot on either side, are large and spherical and contain a refractile body.

The propodium of *C. sordidum* continues to grow after the veliger hatches and becomes a long flexible process which protrudes between the lobes of the velum when the veliger is swimming and probes about actively over the mouth area. After about 14 to 18 days it seems to shorten and widen a little which may be an early indication of approaching metamorphosis, but at this stage the veliger ceases to swim and lies on the bottom of the dish with its cilia beating only occasionally. It remains thus for a few days, intermittently opening and shutting its operculum and constantly exuding yolk. After final withdrawal into the shell, movements of the mantle and cilia may be seen through the shell until the invasion of scavenging protozoa indicate that life has ceased. Eventually there remains only the shell, operculum, statocysts and a residue of black pigment.

C. conicum veligers after ceasing to swim behave in the same manner.

In both species sinking is probably due to artificial conditions rather than to the approach of metamorphosis as it seems unlikely that this would take place until a more advanced foot structure had been attained. The larva of another naticid, *Glossaulax aulacoglossa* (Pilsbry and Vanatta, 1908) has a flexible process-like propodium which develops into an active part of a functional foot well before the veliger loses its velum and crawls from the capsule.* In view of this, it seems reasonable to assume that the larval propodium of *C. sordidum* would develop in the same way, and the veliger would be capable of crawling before it loses its velum. Presuming this elaboration of the foot to be a prerequisite for metamorphosis, it seems likely that the small *C. conicum* veliger spends a long time in the plankton during which period some propodial development takes place.

C. sordidum veligers from eastern Victorian material begin to hatch in about eight days at 20°C and are smaller and less advanced than those from Western Port. The lobes of the velum are at first oval but soon elongate and become rectangular.

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* Paper in manuscript.

PLATE 9.

C. conicum (Lamarck).

Fig. 1: Veliger within the envelope and capsule prior to hatching. The large velar cilia are folded in between the velum lobes. (x 116). Photomicrograph: slightly retouched.

Fig. 2: Hatched veliger, ventral view, showing the large velar cilia. (x 148). Photomicrograph.

THE VELIGER SHELLS

C. sordidum. At hatching the shell averages 0.385 mm. across, but after some periods of growth while the veliger is swimming, it finally averages 0.450 mm. It is translucent and pale horn coloured, later becoming brown-tinged, and consists of about one whorl with a distinct umbilicus and a brown columella. The apex is smooth but the remainder of the whorl is sculptured with fine spiral lines crossed by transverse lines of growth. Specimens have been deposited in the National Museum of Victoria (No. F. 22727).

The larval shells of *C. sordidum* from eastern Victorian material average only 0.375 mm. across after sinking.

C. conicum. Averages 0.188 mm. across at hatching and 0.225 mm. after sinking. It is translucent and pale horn coloured, consists of about one whorl without spiral lines and has an umbilicus and a brown columella (Nat. Mus. Vict., No. F. 22728).

The operculum of each species extends well beyond the foot and is thin and transparent and has the shape and spiral growth typical of the genus.

This study has shown that the two common naticids, *C. conicum* and *C. sordidum* which have a wide geographical distribution, spawn prolifically over a long period. Vast numbers of their pelagic, planktotrophic veligers with elaborate ciliary feeding mechanisms must surely enter the water, but data concerning their behaviour in off-shore and in-shore waters are needed before attempting an evaluation of their importance as constituents of the plankton.

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